Education and Culture DG
Lifelong Learning Programme

CerORGANIC

CerOrganic Training Curriculum

Module C534

Unit C534a.4

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1.i. Tutor information

Dr. Zita Szalai, Ass. Prof. holds an MSc in Horticulture from the former Horticultural University Budapest and a PhD on Biological Sciences. She is member of MÖGÉRT Association responsible for the research and education topics. She lectures on Ecological Farming, Plant production, Agronomy, Lawn Management, Land Use, and Conversion to OA. (MSc & BSc level for Horticulture, and Environment Management Degree programs) and to Erasmus students on Ecological Farming. She also supervises and consults Diploma and PhD research theses.

She has participated in developing and implementing EU supported LdV programs like ECOLOGICA, COMPASS, Ecolearning, Organic Edunet eContentplus, projects. She has authored 84 publications, and 6 chapters in scientific books and booklets.

1.ii. Aims & objectives

- *to present different plant protection methods, and their components and processes*
- *to offer various resources as an introduction to the Biological Control of Pests and Diseases in environmentally-friendly farming systems*
- *to demonstrate the inter-relationship of various components and effects following specific actions and farming practices*
- *to illustrate problems and problem-solving approaches for specific case studies*
- *to analyze specific consultation tools for this particular domain*

1.iii. Learning outcomes & skills

By the end of the unit, the trainees are expected to:

- *have an understanding of the complexity of the Biological Control of Pests and Diseases*
- *be competent to search for resources in literature and the internet*
- *be familiar with several problems occurring in the field of plant protection*
- *be able to analyze critically various solutions leading to decision making in plant protection*
- *have developed consultation skills in the field of plant protection*

1.iv. Methodology & media

The Unit is composed of:
(a) lecture based on PowerPoint presentations: The concept of biological plant protection: regulation, allowed substances, biological plant protection against pests. Biological plant protection against diseases.
(b) web-based literature review
(c) articles
(d) group interaction and discussion
(e) testing

Biological Control of Pests and Diseases

2. Main part

Biological Control of Pests and Diseases

2.i. Glossary

Biological control

Management of pests within reasonable limits by encouraging natural predator/prey relationships and avoiding use of toxic chemicals.

The use of living organisms, or it's derivate againts another organism to keep pest populations below damaging levels

Pesticide

A general term for chemicals used to destroy living things that people consider pests. More specific terms include the following: "Insecticide", a substance that kills insects; "herbicide", a substance that kills plants/weeds; "fungicide", a substance that kills fungi; "fumigant", a substance that kills all organisms in the soil—a soil sterilizer; and "rodenticide", a substance that kills rodents.

Herbicides (chemical synthetic)

Herbicides (chemical synthetic): Chemicals applied to agricultural fields to kill unwanted weeds or other plants growing among commercial or animal feed crops. Chemical synthetic herbicides are prohibited in organic farming.

Biopesticides

Plant protection products which contain biological control agents (microbials, pheromones, plant extracts) for use as agricultural, horticultural and home garden pesticides.

Sustainable—Capable of being continued with minimal long-term effect on the environment, as with sustainable agriculture, which integrates three main goals: environmental stewardship, farm profitability, and prosperous farming communities. Sustainable development recognizes the need to work with living environments in a balanced manner.

Conversion

Conversion: Turning a non-organic agricultural holding into an organic one. The lengthy and complicated process is required by regulations in order to be able to use organic logos and labelling.

Crop rotation

The practice of alternating the annual crops grown on a specific field in a planned pattern or sequence in successive crop years so that crops of the same species or family are not grown repeatedly without interruption on the same field.

Disease vectors

Plants or animals that harbor or transmit disease organisms or pathogens which may attack crops or livestock.

Functional biodiversity: means that part of the total biodiversity serves a specific function, i.e. to reducing a pest species (biological control).

http://www.fibl.org/en/switzerland/research/plant-protection-biodiversity/pb-projekte/functional-biodiversity.html

Farmscaping: is a holistic approach to pest control on farms that focuses on increasing biodiversity in order to maintain healthy populations of beneficial insects, birds, bats, and other wildlife as part of an ecological pest management program.

Green manure crops

Green manure crops: Plants grown to prevent soil erosion and nutrient leaching after harvesting, and to add nutrients and organic matter to the soil when being ploughed into the ground. Green manure crops are in regular use in organic farming.

Organic Control of Pests and Diseases

2.ii. Presentation

Methods of Plant Protection in Agriculture

- Conventional
- Integrated (IPM)
- Organic (OPM)

Organic Plant Protection
Conventional Plant Protection

- The goal of **organic** plant protection is not the total destruction of pests and pathogens, but to keep them under the economic threshold and to create balanced operation.
- The most important tool: to develop a strong, healthy crop more tolerant of damage.

- In **Conventional** plant protection – avoidance of damage (loss) by eliminating / killing the pests causing the economic losses.
- The most important tools are: by far the use of different "killing" compounds (-*cide*, fungi*cide*, bacteri*cide*, insecti*cide*, acari*cide* etc) Prevention of damage using agrotechnical, biological and other plant protection methods are much less important.

IPM

- the aim of *integrated plant protection* is similar to conventional farming, but with greater consideration for the environment (presence of useful organisms)
- considers the harmful effect of chemicals on the environment
- encourages the selection of less harmful “green” chemicals
- control is not fully developed

The importance of the conversion period

- Natural removal of any residues of chemical protection products
- Development of the ecological environment of the farm – ecological association
- Build up of the natural ecosystem as part of the productive area - biotopes
- Creation of organic farm
- Organic farming ≠ the exclusion of conventional chemicals, and replacement with permitted ones

Two important phases

- Prevention
- Protection

Tools of Plant Protection in Organic Farming

Method	Prevention		Protection			
	cultivation methods	**Infection free**	**biological**	**physical**	use of permitted chemicals substances	
Tool	Site selection	propagation material	viruses	collection	bactericides	
	soil cultivation	soil	bacteria	attraction	insecticides	Natural substances
	nutrient management	irrigation water	fungi	alert	acaricides	Plant extracts
	rotation			heat treatment	fungicide	
	sowing time, vegetation period		vertebrata	changing of agent		
	crop density		birds	inhibition with tool		
	selection of variety		mammals			
	destruction of infected plants		reptilia			
	elimination of vectors		autocide method			

Prevention

Prevention methods in Organic Plant Protection are based on:

- *Environmentally-friendly farming system*
- *Cultivation methods*
- *Selected cultivars*

The most important method in organic plant protection is prevention

The tools of production methods

- selection of production area
- soil cultivation
- nutrient management
- crop rotation
- sowing time
- vegetation period
- crop density/regulation
- selection of variety
- destruction of infected plants
- elimination of vectors

Prevention: Site selection

- Ecological farming can only be successful if the plants needs are fulfilled by the environment.
- Careful consideration in the selection of the production site. (Exposure, humidity, soil properties)
- Selection of the best suitable plant species/cultivars – according to the ecological conditions of the site

Production site, exposition, suitable for the cultivar

- A good slope is perfect for grape growing.

Determinant Environmental Factors

- soil conditions
- terrain, slopes, and valleys
- precipitation
- temperature
- the conditions influencing the microclimate
- specific characteristics of the living environment – presence or absence of a natural ecosystem

presence of a natural ecosystem

Biologically active soil

- Balaced terrestrial ecosystem
- reduce the occurence of the diseases

Proper Soil Cultivation

- influences the **condition** **of the crop**.
- rapid and **uniform germination**
- moist conditions
- a well-compacted fine earth
- uniform soil surface
- Speed in development and uniformity of germinating seeds help the formation of healthy culture
- Allow the proper root development of the plant

Direct impacts of soil cultivation

- Selected methods of soil tillage, frequency of tillage
- Tools of soil tillage
- Balanced nutrient management
- Green manuring
- Intercropping
- Under-sowing
- Mixed vegetation (culture)
- Crop rotation

Balanced Nutrient Management

- natural substances for nutrient supply
- manure, green manure and compost
- most balanced concerning macro- micro- and trace elements
- the nutrients are not directly supplied to the plant but pass through the active nutrient-serving systems of the soil

Nutrient management

- the nutrients are delivered in a larger proportion bound in organic matter respectively to water insoluble forms/fertilisers
- resulted active bio-association rich in species
- realize that soil biology is reliant upon both soil structure and available nutrient (water)
- Microbiological antagonism an important factor

Crop rotation

- **cultural control of pests and diseases**
- a direct impact on plant protection
- monoculture is out of question having harmful consequences in plant protection even in the case of species relatively tolerant of monoculture, such as maize.
- crop rotation is compulsory in organic farming

Crop rotation

- Basic principles:
- Avoid the sequence the same taxonomic family
- Broken or limit the pest cycles
- Keep the safe return of a cultivar the same plot
- Sunflower –fungal disease, Slerotinia
- Other susceptible species. Soya been, Rape
- Cultivating precrop/secondary crop on the same plot

Cultivation methods

- Green manuring
- Example: Cruciferae
- – nematocid effect

Oliseed radish

White mustard

Intercropping

- Intercropping: cereals with grain legume
- Example: Aphids can be reduced in Barley
  Barley + Alfalfa ---- Parasitic Wasp Increase

Benefits of Organic Farming Intercropping

- Better use of growing area
- Increased insect pest and disease resistance
- Increased insect predator populations
- Increased yields per area grown
- Increased weed suppression
- Increased soil micoroganism activity
- Plant diversity creates overall plant health
- Better long term soil use
- Trap cropping for pest control
- Physical, spatial interactions

Lupin with wheet and oat

Sowing time, vegetation period

- choice of sowing time
  - optimal vegetation periods
- avoiding the population of the insect pests
- e.g. *Phyllotreta undullata* - Crucifearae
- sowing before the pests starts hatching/developing

Crop density

- High density cultivation of plants creates ideal conditions for many pathogens.
- In addition, spraying of the plant protection products authorized for ecological farming (which are all contact products) is less efficient in dense cultures.

Selection of varieties

- Good adaptibility
- Resistant, tolerant
- Less demanding of soil properties, nutrients – regional, native varieties
- Suitability for ecological conditions
- Healthy propagation material
- Example: Peach in Hungary:
- „Hungarian peach”

Elimination of vectors

- Elimination of the transmitters responsible for spreading of parasites can also prevent the spreading of some parasites.
- Examples: aphids, weeds
- In ecological farming there are no special regulations for the use of these procedures, they can be applied in a similar way as in conventional plant protection

Example

- The most important vector of the viruses on beet, is the peach-potato aphid (Myzus persicae)

Plant association - mixed culture

- this method is rarely used in conventional farming, especially due to the use of herbicides and the harvest technologies, but widely used in ecological farming, with a multiple plant protection effect.
- associated plants help each other to meet environmental and nutrient needs, and act as repellents to each others pests
- e.g. growing of maize, with beans and pumpkin
- plant varieties may serve as a food supply for useful organisms

Onion with carrot

Delia antiqua

Psila rozae

Infection free propagation material, soil and water

Assurance of infection-free propagation material, soil and water for irrigation.

- The propagation materials should originate from registered producers, produced especially for marketing purposes
- Similar to conventional farming
- Optimal supply of irrigation water

Biological control

- is the use of living organisms and its derivates to maintain pest populations below damaging levels.
- natural enemies of arthropods fall into three major categories:
  - predators
  - parasitoids
  - pathogens

(Altieri *et al*., 2005; Mahr *et al*., 2008).

Predators

- Predators catch and eat their prey.
- Some common predatory arthropods :
  - lady beetles,
  - carabid (ground) beetles,
  - staphylinid (rove) beetles,
  - syrphid (hover) flies,
  - lacewings,
  - minute pirate bugs,
  - nabid bugs,
  - big-eyed bugs,
  - spiders.

Parasitoids

- Parasitoids do not usually eat their hosts directly.
- Adult parasitoids lay their eggs in, on, or near their host insect. After hatch, young parasitoids use the host as food.
- small size
- Parasitoids often require a source of food in addition to their host insect, such as nectar or pollen.
- Encarsia formosa

- Example: Tachinid flies are a group of parasitoids. Similar to houseflies – they deposit their eggs on caterpillars and other pests. After hatching the young, enter the host, and kill it.

Eggs of Tachinid Fly on Tobacco hornworm

Pathogens

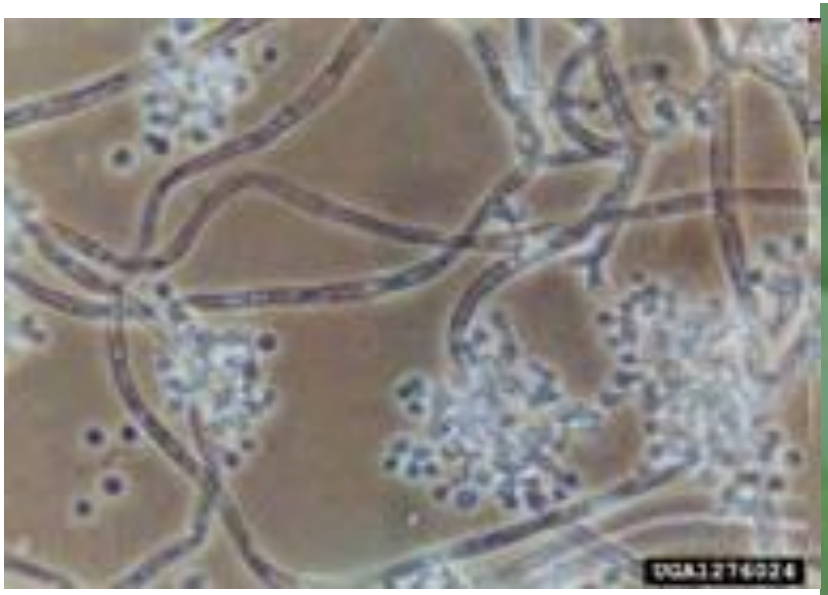
- pathogens are disease-causing organisms.
- the main groups of insect disease-causing organisms are:
  - insect-parasitic
  - bacteria,
  - fungi,
  - protozoa,
  - viruses, and
  - nematodes.

Bacteria

- Biological control using pathogens is often called microbial control.
- One very well-known microbial control agent that is available commercially is the bacterium *Bacillus thuringiensis* (Bt).
- Because not all formulations of Bt are approved for use in organic systems, it is important to check with your certifier before use.
- *Sacharospora sinosa* spcecial effect with blocking the nervous system through influencing the Na and Cl ion activity of cell membran

Fungi

- Several insect-pathogenic fungi are used as microbial control agents, including *Beauveria*, *Metarhizium*, and *Paecilomyces*.
- These are most often used against foliar insect pests in greenhouses or other locations where humidity is relatively high.

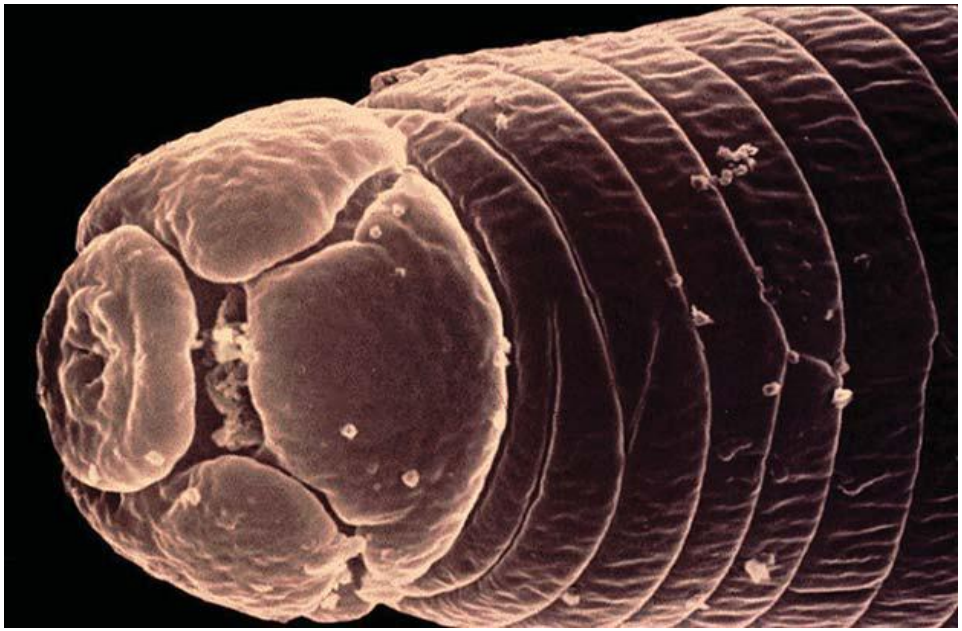


Beauveria bassiana conidia, and phialides
Svetlana Y. Gouli

Insect parasitic nematodes

- entomopathogenic or insecticidal nematodes:
- *Steinernema* and *Heterorhabditis*, infect soil-dwelling insects and occur naturally or can be purchased.

Example: Problems in potato growing



***Root-knot nematode*—Meloidogyne brevicauda Loos**
©Jonathan D. Eisenback, Virginia Polytechnic Institute and State University

Types of potato nematodes

- Endoparasitic root feeders include
- economically important pests as the rootknot nematodes (*Meloidogyne* species)
- the cyst nematodes (*Heterodera* species),
- and the root-lesion nematodes (*Pratylenchus* species)
- etc

Protection against nematodes rely on prevention

- Growing site selection
- Cleaning the equipments
- Clean irrigation water
- Compost the manure
- Nematode supressive manures
- Nematode supressive cover crops
- Crop rotation and cover crop
- Plant resistence

Sorgum and oil radish

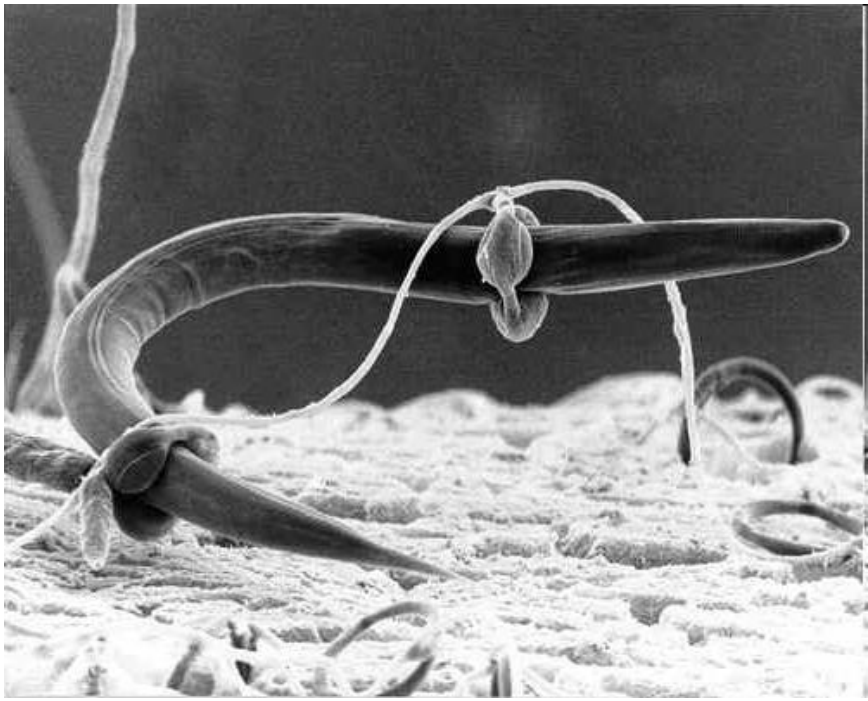
glucosinolates

Trap crop

What else?

- Botanical insecticides

- Microbial phatogens
- Beneficial nematodes
- Fungi



Arthrobotrys oligospora
Trapping Fungus

On horticultural crops

- Meloidogyne hapla

Virus

- Nuclear polyhedrosis (NPV) and granulosis (GV) viruses are available to control some caterpillar pests.
- As with all biological control agents, it is especially important to match the correct microbial control agent with the correct pest in order to be effective.

Approaches to Biological Control

Biological control can be:

- natural: *conservation of natural enemies, and habitats*
- or applied: introduction of useful organisms into the growing system *inoculation or inundation*.

Conservation of Natural Enemies

- In many cases, purchasing natural enemies to provide biological control agents is not necessary.
- Natural enemies are common and a grower can design production systems to attract and keep the natural enemies in the system by providing environmental conditions conducive to the enemies' survival.
- Farmscaping is a term used to describe the creation of a habitat to enhance the chances for survival and reproduction of beneficial organisms

Inoculation and Inundation

- Inoculation and inundation involve the supplemental release of natural enemies to build populations of beneficial organisms.
- *Inundation* provides an immediate but nonsustainable reduction in the *pest* population
- *Inoculation* is frequently done prophylactically, before *pests* become a problem.
- Many biological and microbial control agents are commercially available for purchase.

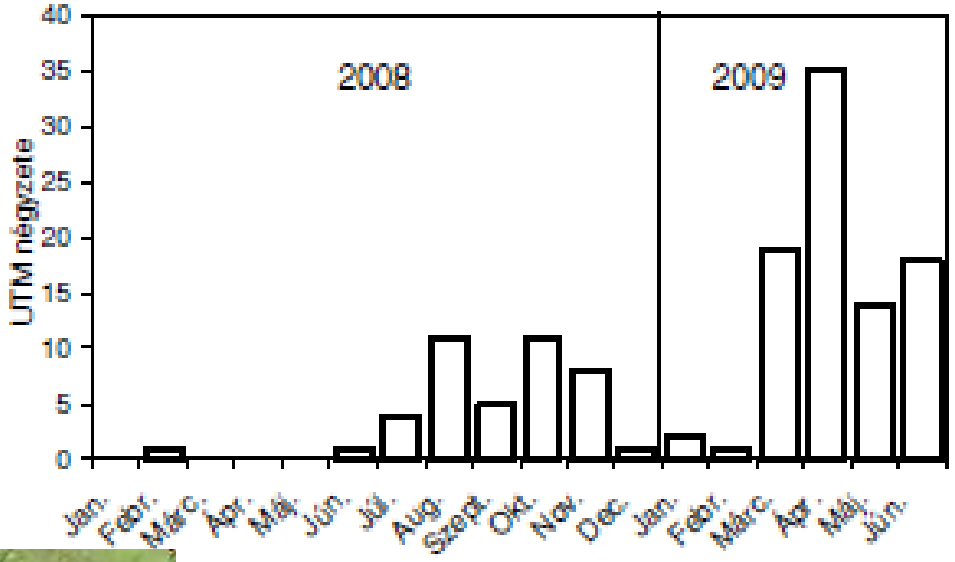
Introduction of species not native to the region

Can a useful insect became pest?

- Recent example:
- Harlequin Lady beetle
- (Harmonia axyridys)

- Criteria of introduction of new promising species:
- Good adaptibility
- Rapid reproduction
- Autstanding competion with fellow species

Occorence of Harmonia axyridys in Hungary (Markó, Pozsgai 2009)



•What are you consuming?

Threat to local biodiversity?

- How can be prevented from further speading?
- Careful consideration of new species introduction to a certain ecosystem.

Example of microbial preparations againts fungi

Product in HU	Useful organism	Target organism
Oko-ni	*Coniothyrium minitans* (fungus)	white mildew
Mycostop	*Streptomyces griseoviridis* (bacterium)	Pythium, Rhizoctonia damping off Fusarium, Verticillium wilting diseases
Trichodex WP Withdrawal in the EU 2010	*Trichoderma harzianum* (fungus)	grey mildew

Examples of biological plant protection agents

Product	Useful organism	Application area target organism
Bactucid P	*Bacillus thuringiensis* var. kurstaki (bacterium)	butterfly worms, moth
Dipel and Dipel ES	*Bacillus thuringiensis* var. kurstaki (bacterium)	butterfly worms, moth
Eco-Bio	*Bacillus thuringiensis* var. kurstaki (bacterium)	butterfly worms, moth
Encarsia-sheet	*Encarsia formosa* (chalcid wasp)	greenhouse whitefly
En-Strip	*Encarsia formosa* (chalcid wasp)	greenhouse whitefly
Novodor FC	*Bacillus thuringiensis* var. urstaki (bacterium)	Colorado beetle, leaf beetle
Thuricid HP	*Bacillus thuringiensis* var. kurstaki (bacterium)	butterfly worms, moth

Physical protection

- the aim is to exclude or remove pests from the crop to be protected
- the tools are as in conventional farming - except that the use of ionizing radiation is prohibited.
- this method plays a much greater role in ecological farming
- a thorough knowledge of pest biology, behaviour, and localization on the plant is required

Collection

- hand collection has been applied frequently in the past (i.e. collection of Colorado beetles, of egg bunches, etc.)
- the mechanical collection has become a basic technological element in the case of some insect/pests
- Special tools, machines have also been developed

Collection of potato beetle

- Devices is to collect the beetle and the larva

Attraction

- the collection will be more successful if pest are attracted
- example: eggplants as border plants in potato cultures attract potato beetles
- Colour traps, sticky traps
- Light traps
- Scent

Colour traps

- Blue - tobbacco trips
- Yellow – cherry fly, aphids, white fly, leaf miner flies
- White – fruit wasps (*Hoplocampa sp*.)

Cherry fly

Aphids, White fly

Pheromone traps, Pheromone lures

- Good prediction tool of population dynamics
- *Lepidoptera*, moths
- Attractant; sexual behaviour disrupter; only in traps and dispenser

Forecast of pests with pheromone traps in fruit and grape

- *Cydia pomonella*
- *Grapholita funebrana*
- *Grapholita molesta*
- *Adoxophyes orana*
- *Lobesia botrana*
- *Eupoecilia ambiguella*

Mating disrupter, confusing feromon

- Useful tools in the plantation during the vegetation season (5-6 moths)
- The evaporation of the sexual preromones covers the signal of females moths –
- It needs at least 2-3 ha minimum territory
- *Cydia pomonella, Pandemis heparada*
- *Adoxophyes orana*

Alert

- The application of alert stimuli – besides prevention – is the most desirable plant protection method in ecological plant protection.
- Artificial or natural origin

Heat treatment

- A protection method based on the different heat tolerance of the damaged plant and the parasite.
- Hot water (52 - 53 °C) treatment of cereal seeds is a historic example whereby the fungal thread of the flower-infecting smuts inside the seeds is killed.
- Vegetative propagation materials (bulbs, tubers) can be freed of viruses by the use of periodic heat treatment.

Physical protection

obvious ***physical protection*** methods are the following:

- changing the means of storage: substitution of oxygen (with CO_2 or N_2); isolation of storage areas (mounting of gratings, fly-screens);
- individually covering fruits (putting into bags) to protect against flies, moths etc;
- use of veil foil: by covering a part of the plant parasites (cabbage maggots, fleas, moths, plant-louses etc) can be kept away from the cultivated plants




- covering of tree trunks to avoid damage by wild animals.

Chemical protection

- in the case that preventive biological and physical protection methods are not effective, certain chemical protective substances may be used.
- In ecological farming a strictly defined range of plant protection products may be used, the regulations contain these in the form of **positive lists.**
- **the products registered on the "positive lists"** may be applied but only with permission of the control/certification organization.
- In Hungary (and also in the European Union) the positive lists may be found at:

  http://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=OJ:L:2008:250:0001:0084:EN:PDF

  http://eur-lex.europa.eu/LexUriServ/site/en/oj/2007/l_189/l_18920070720en00010023.pdf22

Plant conditioners, plant extracts

- Nettle, equisetum,
- K-silicat
- Effect epidermis
- Inducing active protective mechnisms
- New in viticulture MycosinVin Al ions
- Preventive applicaton – Copper alternative
- Herb oils + K silicat induced resistency (Oikomb in vine against grey mold, powdery mildew)
- Potassium bicarbonate chnanging the pH on leaf surface (VitiSan)

Steps for Successful Biological Pest Management

Pest Prevention - Control starts with prevention. Learn about beneficial insects to help with pest control in the garden.

Identification of the insect problem - to identify the insect pest

Assessment of Insect Damage - to see exactly what and where the damage is.

Selection of Insect Control Tactic - most appropriate organic tactic for the damage.

Implementation of Insect Control - knowledge before implementation

Re-assessment of Insect Damage - monitoring insect populations and crop yields after implementation - if the desired suppression has been achieved

Follow-up Periodic Assessment - constant observation is required to prevent unexplained and unpredicted pest population outbreaks

3. Conclusions

3.i. Summary

- Organic plant protection is a comprehensive approach instead of a chemical approach.
- Create a healthy biodiversity so that the insects and microbes will control themselves
- Using natural products and building healthy soil is the best long-term treatment for pests.

Useful websites for organic and biological pest control and products in the practical application

- http://www.channel.uni-corvinus.hu/content.php?content.40
- http:/www.greenplantprotection.eu
- www.koppert.com/pest-control/guidelines/biological-control/
- http://www.biobest.be/home/3
- http://www.biobest.be/teelten/40/3/0/0/
- http://www.infoxgen.com/produktsuche-biologisch.html
- http://www.infoxgen.com/produktsuche-biologisch.html
- https://www.fibl-shop.org/shop/pdf/1032-betriebsmittelliste.pdf

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Agroecology: principles and strategies for designing sustainable farming systems.

http://web.mac.com/profcatpcc/iWeb/Site/Environmental%20Science_files/soil-pestmgmt.pdf

Miguel A. Altieri: Agroecology: principles and strategies for designing sustainable farming

http://www.agroeco.org/doc/new_docs/Agroeco_principles.pdf

M. A. Altieri, C. I. Nicholls: Ecologically based pest management: a key pathway to achieving agroecosystem health

http://www.unicamp.br/fea/ortega/agroecol/ecpestma.htm

Web pages / links

http://eur-lex.europa.eu/LexUriServ/site/en/oj/2007/l_189/l_18920070720en00010023.pdf

http://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=OJ:L:2008:250:0001:0084:EN:PDF

http://www.fibl.org/en/switzerland/research/plant-protection-biodiversity/

http://europa.eu.int/

http://www.fao.org/organicag/

http://www.ifoam.org/

http://www.fibl.org/en/

http://portal.organic-edunet.eu/

http://orgprints.org/

http://www.channel.uni-corvinus.hu

http://www.greenplantprotection.eu/

http://www.nysipm.cornell.edu/organic_guide/

http://www.springer.com/life+sciences/entomology/journal/10526

3.iii. Evaluation of Learning

The assessment includes a **multiple-choice test**, which gives the participants to face various problems on the field of organic pest and disease management and improves their ability with the analysis of various solutions.

For more information on module C534a.4

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